HydroWatch Proposal

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1 Introduction

The world is full of wearable devices. Recent devices of interest, such as the fitbit and Apple Watch, provide the user with information regarding their heart rate and movement throughout the day. With these devices, users receive quantitative and qualitative information regarding their health. A key component of health is hydration. The prevention of dehydration has always been a vital part of survival, but a practical wearable device that is able to inform an individual of their hydration level does not currently exist. We propose the construction of a wearable device that, based on a baseline measurement, communicates to the user a relative hydration level and advises the user when to drink water to rectify low hydration levels. We will determine relative hydration based on optical properties and the capillary refill rate of the skin, process this data within the device on a microcontroller, and communicate the results to the user.

2 Problem Description

In order for life to be sustained, water must be present within the body. Humans can only survive for a few days without water, which is required by our organs for operation. When one contains a sufficient amount of water in their tissue, they are considered to be hydrated. Currently there are no noninvasive practical wearable systems that can provide information about hydration levels to a user. An additional issue is that many people wait until they are thirsty to drink water. At that point, however, the body is already dehydrated and has begun to shift water to vital organs. In fact, the general population of people do not know how to assess their own hydration level. Dehydration can lead to numerous health problems and complications including: exhaustion, lack of strength, and rapid heartbeat. We seek to design a device that will inform a user when a drop below an established level of hydration is noted and suggest consumption of water.

3 Proposed Solution

This device will consist of three components. The first is the detection of hydration in the body. This detection will be implemented through the use of LEDs to optically measure the amount of water, electrolytes, and other substances present in the tissue, which change based on the hydration of the user. The second component is the processing that will be done on the device through a microcontroller, which will analyze the received data and produce an indicator based on the results. The third and final stage will be alerting the user to their hydration level.

4 Demonstrated Features

<u>Show optics measurement on two separate phantoms</u>

- Demonstrate that LEDs of different wavelengths can be illuminated
- Send the light from these LEDs into a phantom with a known water concentration
- Detect and measure light at photodetector surface in the form of a current
- Convert the current to a voltage and pass it to the microcontroller

- Analyze these voltage values on the microcontroller and produce an executable outcome that will present information to the user
- Repeat the procedure with a phantom containing a different water concentration and examine differences

<u>Demonstrate above features on human test subject during rehydration</u>

5 Available Technologies

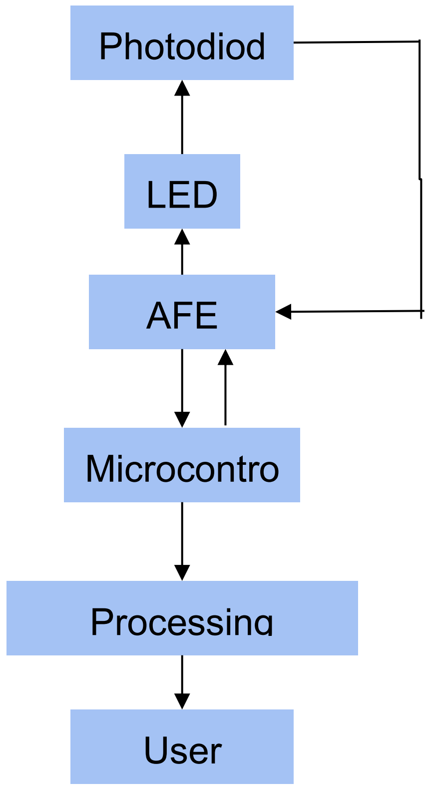
- Wearable band ~$10
- Multiple LEDs (near IR and IR) (6) < $1 each
- Photodiodes (3) ~ $1 each
- OpAmp ~ $5
- AFE4490 microcontroller (3) ~$20 each
- LCD screen for results ~ $3
- Circuit board ~ $50
- RSL10 Bluetooth ~ $10
- Evaluation board for RSL 10 and AFE4490
- Phantoms (2) ~ $20

Costs can be minimized by consulting with available components in Dr. Thomas O'Sullivan's lab.

6 Engineering Content

1. Communication to LEDs
2. Photodiode measures the light present
3. Measuring photodiode response at microcontroller
4. Processing data
5. Create program to display information to user

First, we will set up several LEDs at different wavelengths and ensure that they can each be lit at separate intervals. The LEDs will be controlled through the AFE4490 chips, which allow front-end processing of various optical measurements. We will then place these LEDs so that the light propagates through a phantom with known optical properties. Next, we will place several photodetector at a set distances from each LED and record the light that interacts with the surface in the form of a current measurement. This current will then be passed through an OpAmp to convert it to a measurable voltage value, and then sent to the microcontroller for processing. The microcontroller will analyze the various voltage values and determine the amounts of materials present, which will include water, electrolytes, and other substances. The microprocessor will then provide an executable outcome, which will involve providing a signal indicating the hydration level. The procedure will then be repeated with a phantom of a different concentration of materials, and the difference in results between these two tests will be analyzed. Once we are able to achieve distinguishable results between the two phantoms, we will move on to testing on a human subject before and after they receive hydration.



7 Conclusions

HydroWatch will give the general population access to a device that simply and accurately measures the users hydration level. With the wide range of wearable devices on the market today for heart rate and movement, this device will add a unique functionality to the lives of many. Various LEDs and photodetectors will measure multiple tissue components to determine a level of water content in the body relative to pre-established level. Hydrowatch will help users stay healthy and hydrated with alerts when water levels drop below that individual's threshold.